CALIFORNIA AMPHIBIAN DECLINES AND HISTORIC PESTICIDE USE

FINAL REPORT

TO THE U.S. FISH AND WILDLIFE SERVICE, SACRAMENTO OFFICE

In Satisfaction of Order #101811M955

January 2003

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Abstract

Pesticides have long been proposed as a possible cause of amphibian population declines, but due to a number of challenges there has been relatively little ecotoxicological research on pesticides and amphibian declines. This study examined the association between the spatial pattern of declines for five California amphibian species and historic pesticide use in California from 1974 to 1991 based on Department of Pesticide Regulation records. Information on declines was derived from maps of historic sites and current population status for the Yosemite toad (*B. canorus*), California red-legged frog (*Rana aurora draytonii*), foothill yellow-legged frog (*R. boylii*), Cascades frog (*R. cascadae*), and the mountain yellow-legged frog (*R. muscosa*). Multiple logistic regression was used to analyze the relationship between site status (present or absent) and total upwind pesticide use, pesticide classes, individual pesticides and covariates including precipitation, latitude, elevation, and surrounding urban and agricultural land use. Total pesticide use was a strong, significant variable in the logistic regression models for all species, except *B. canorus.* In the analysis of pesticide classes and individuals, no single class or pesticide emerged as most strongly associated with declines. Instead a different set of multiple classes and individual pesticides were associated with declines for each species. The only pesticide to stand out was carbaryl and the N-methyl carbamates class. This is the first study in which population declines of multiple declining species have been associated with historic pesticide applications.

Introduction

Assessing the role of pesticides in amphibian population declines presents scientists with difficult challenges. First, field studies of pesticide residues in the environment typically only analyze samples for a handful of different chemicals. And laboratory experiments on pesticide effects are usually done with only a single or a few pesticides. Yet, several thousand different pesticides are currently in use or have been used in the recent past, overwhelming the ability of field studies to detect and lab experiments to assess even a small fraction of pesticides. Second, the phenomenon of amphibian population declines occurs on large temporal and spatial scales. However, laboratory and field experiments are necessarily restricted to effects on individual animals or small groups of animals, leaving a large inferential leap in extrapolating experimental results to population level effects. Third, laboratory studies on pesticides and amphibians have mostly evaluated acute lethality. Yet, if pesticides are playing a role in amphibian declines, it is probably due to sub-lethal effects and possible synergisms with other factors such as disease (Taylor et al. 1999; Gilbertson et al. In press). Fourth, other factors such as introduced predators (e.g., Fisher & Shaffer 1996; Lawler et al. 1999; Knapp & Matthews 2000) and habitat destruction (Davidson et al. 2001; Davidson et al. 2002) have certainly contributed to declines, making it difficult to disentangle the role of pesticides. Finally, although pesticides have long been suggested as a possible cause of amphibian declines (Carey & Bryant 1995; Stebbins & Cohen 1995; Drost & Fellers 1996; Lips 1998), there have been few toxicological studies on declines. This is the first study in which population declines of multiple declining species have been associated with historic pesticide applications.

Epidemiologists regularly deal with the problems of assessing the causes of events with multiple factors, operating on both large temporal and spatial scales. Observational studies are not a substitute for laboratory or field experiments, but they provide essential direction and insight for experimental work, and in turn support causal inferences on the population level from experimental work on individuals. This study uses an epidemiological approach to examine the role of pesticides in the decline of five California amphibians, the Yosemite toad (*B. canorus*), California red-legged frog (*Rana aurora draytonii*), foothill yellow-legged frog (*R. boylii*), Cascades frog (*R. cascadae*), and Sierra Nevada populations of the mountain yellow-legged frog (*R. muscosa*). The species were selected based on earlier work indicating that declines for the species were associated with the amount of upwind agricultural land use, suggesting that windborne pesticides may be contributing to declines (Davidson et al. 2001; Davidson et al. 2002).

California accounts for 25 percent of total U.S. pesticide use even though it has 2-3% of total planted cropland in the country. California farmers used over 90 million-kg of pesticide-active ingredients in 1998 alone (Department of Pesticide Regulation 1998). In California in the late 1960's public concern about the effects of the pesticide DDT helped spur legislating requiring the reporting of commercial pesticide use. As a result California has what are probably the most extensive records of pesticide use for any large area in the world. Since 1970 the California Department of Pesticide Regulation has required licensed agricultural pest control operators to report all pesticide use, and farmers to report applications of all pesticides labeled by the state as restricted use chemicals.

Pesticide use reports contain information on the date of application, location, specific chemical product, and amount of active ingredient. Locations are based on Public Land System sections and thus provide a spatial resolution of 1 mi^2. Although the California reporting system is the most comprehensive, there are shortcomings. The pre-1990 data has not been subjected to rigorous quality control. And until regulatory changes in 1990 required so called "full reporting", farmers did not have to report use of non-restricted pesticides.

California is an excellent place to study the role of pesticides in amphibian declines. In addition to high pesticide use, and extensive historic pesticide reporting, the state has experienced sharp declines of many amphibian species (Jennings 1988; Fellers and Drost 1993; Jennings and Hayes 1994, Drost and Fellers 1996, Fisher and Shaffer 1996). California also has a strong record of historic, museum-based collections and ongoing field surveys, providing the broad baseline of data necessary for this analysis (Shaffer et al. 1998). Finally, transport and deposition of pesticides from the agriculturally-intensive Central Valley of California to the adjacent Sierra Nevada is well documented (Zabik & Seiber 1993; Aston & Seiber 1997; Datta 1997; McConnell et al. 1998; LeNoir et al. 1999), and pesticides have been found in the bodies of Sierra frogs (Cory et al. 1970; Datta et al. 1998; Sparling et al. 2001).

The population data in this study is presence/absence information for multiple sites. I define "present" sites are those that are currently occupied by a species, and "absent" sites are those that were previously occupied (based on museum or other historic records) but

are currently not occupied. "Declines" refers to sites, or proportions of sites, which are currently absent. I examined the spatial pattern of declines in relation to the pattern of historic pesticide use as documented by California Department of Pesticide Regulation records from 1974 to 1991. The goal of the research was to determine whether total pesticide use upwind from a site was a significant predictor of site status (present or absent) once other covariates such as elevation, latitude, precipitation, and surrounding urban and agricultural land use were taken into account. A second goal was to analyze which specific classes of pesticides and individual pesticides were most associated with the patterns of decline for each species.

Materials and Methods

I used maps made by Jennings and Hayes (1994) to document the spatial patterns of decline for five California amphibians. The individual species maps indicate whether populations are still present or not at historic sites at the time the maps were made in October 1991. The maps are based on verified museum records and extensive field surveys, and provide the most comprehensive evaluation of California amphibian declines available for a single point in time. A geographic information system (GIS) was used to digitize the maps producing a spatial dataset of 1,083 sites, for five species, spanning the entire state (Table 1). See Davidson et. al (2002) for more details on the creation of the dataset and accuracy assessments.

I used U.S. Geologic Survey 1:250,000 scale digital elevation models for California to derive elevation for all sites, and estimated the 60-year (1900-1960) average annual precipitation for each site based on a Teale Data Center digital precipitation map of California. Latitude for each location was determined directly from the coordinates for the site. To assess the contribution of habitat destruction to declines, I measured the percentage of urban and agricultural land use in a 5-km radius surrounding each site based on USGS digital 1:250,000 scale land use/ land cover maps.

Historic pesticide use data for California came from annual Pesticide Use Reports produced by the California Department of Pesticide Regulation (DPR). The reports contain more than half a million records of pesticide application information per year. Since the maps of frog status were based on information as of the end of 1991, I was interested in historic pesticide use data up to and including 1991. I used Pesticide Use Report data for 1974, the earliest year of data without major errors, and then for every odd year through 1991, resulting in a dataset with 10 years of data and 7.4 million records. Every other year of data was used to reduce data cleanup work and the overall size of the final dataset. Pesticide applications were highly correlated from year to year, with an average Spearman rank order correlation of 0.93 for total pesticide use upwind from sites for the five species across all consecutive every-other-year pairs (1975-1977, 1977-1979 etc.). Correlations for classes of pesticides were less than for total pesticide use, and for individual pesticides less than for pesticide classes. For example, correlations for N-methyl carbamates and organorphosphorus classes were 0.92 and 0.89 respectively, and 0.87 and 0.78 for the individual pesticides carbaryl and malathion. Given the high

correlations, the every other year dataset adequately represented the historic patterns of pesticide use.

The pesticide data was subjected to extensive cleanup and verification including removal of duplicate entries, checking the validity of all public land system locations and chemical codes, where possible imputing missing public land system locators, and checking that the number of acres treated did not exceed the 700 maximum acres in a single public land system section which the maximum area covered by a single application record, The original pesticide data prior to 1984 contained errors in the conversion of liquid volumes to weights, which were corrected for the bulk of records based on current DPR formulas. Finally, extremely large applications (based on "application rate" which is the weight of pesticide active ingredients applied per acre) that likely represented errors in the data were removed based on four outlier criteria devised by DPR (Wilhoit 1998). The criteria are application rate greater than 200 pounds per acre (or 1000 pounds per acre for fumigants), application rate greater than 50 times the median, greater than 4 standard deviations above the median, or 4 standard deviations above the mean application rate for a product on a specific crop in a specific year. Only agricultural applications contained the detailed location information required for this study and therefore all analysis was based on pesticide use in agriculture. Agriculture typically accounts for 90-95 percent of reported pesticide use in the state.

Historic (1974-1991) pesticide use upwind of each amphibian site was calculated by first estimating the predominant summer wind direction for each site from streamline wind

maps for California and wind direction data from weather stations (Hayes et al. 1984). I used summer wind patterns because analysis of regional wind patterns in the San Francisco Bay Area, South Coast, Sacramento and San Joaquin regions indicates that the predominant summer wind pattern in all regions is also the predominant annual wind direction (Hayes et al. 1984). Summer and spring, which have similar wind patterns, are also when roughly two-thirds of California agricultural pesticides are applied (Department of Pesticide Regulation 1990; Department of Pesticide Regulation 1994). To define the area I considered to be upwind from a site, I used GIS to construct an "upwind triangle," 22.5° (= 1 compass sector, where each sector equals one of the 16 standard compass directions) wide, 100 km long, and facing upwind (Fig. 1). For each amphibian site, upwind pesticide use was calculated based on all the public land systems sections (1-mile squares) that fell entirely or partially within the upwind triangle. I used an inverse distance weighted measure of pesticide use to capture the joint effect of *amount* of upwind pesticide use, and the *proximity* of the application (Fig. 1). Total upwind pesticide use for a single site was calculated as $\Sigma_y\Sigma_c\Sigma_i (k_{icy} / d_i)$, where k_{icy} is the weight of pesticide active ingredient for pesticide c applied in year y in the ith public land system section within the upwind triangle, d_i is the distance from the centroid of the i^{th} section to the amphibian site, and the summation is across all i sections within an upwind triangle, across all c individual pesticides, and across all y years of data. Similar measures were also calculated for individual pesticides, and for pesticide classes. Pesticide classes are groupings of individual pesticides based on similarity of chemical structure. There are multiple pesticide classification systems (e.g., Hayes & Laws 1991). I used a classification scheme developed by Orme and Kegley (2002) because unlike other schemes it contained DPR

chemical codes that matched the Pesticide Use Report data and included most of the pesticides in my dataset (representing 99.999% of total pesticide use by weight).

In my 1974 - 1991 dataset 821 different pesticide active ingredients were reported as used in California, yet many of these pesticides were used in relatively small amounts, in only a few locations or only in a few years. If a pesticide was not used or only little used upwind of where a species declined, then it is not biologically plausible that the pesticide was contributing to declines. To identify pesticides plausibly associated with declines, individual pesticide use was calculated for all absent sites together, for each species. Only individual pesticides and classes of pesticides meeting the following minimum use criteria were included in subsequent statistical analysis: total use greater than 10,000 pounds active ingredients from 1974 to 1991, used at least once in at least 20 percent of the counties intersected by the combined upwind triangles of all the absent sites, and used at least for an average of two years in all the counties in which it was used. These criteria greatly reduced the number of pesticides considered for variable selection in multivariate modeling, but included pesticides that accounted for the vast majority of pesticide use. For example, for *R. a. draytonii* there were 754 different pesticides used upwind of absent sites, but the 224 pesticides that met the minimum use criteria accounted for 97.3% of the total use upwind from absent sites.

Statistical analyses of pesticide variables was divided into three hierarchical levels: (1) models for total pesticide use and covariates, (2) models for pesticide classes, and (3) models for individual pesticides. All analyses were conducted for each of the five species

separately. I used univariate, nonparametric Mann-Whitney rank tests (Sokal & Rohlf 1995) and box plots to evaluate differences in the mean value of characteristics for present and absent sites. I used logistic regression to evaluate the multivariate relationship between declines and pesticide and geographic, precipitation, elevational, and land use covariates (Hosmer & Lemeshow 1989).

To construct models for total pesticide use, I first built a full model with total upwind pesticide use and all covariates, and then one by one removed variables that did not significantly contribute to the model based on a likelihood ratio test (Hosmer & Lemeshow 1989) to derive a reduced model with only significant variables. Examining which pesticide classes and individual pesticides were most associated with declines required a different analysis approach due to the difficulty of variable selection with a large number of highly correlated variables. For the class and individual pesticide models I retained all the significant covariates from the total pesticide use model for each species and initially used a forward step procedure to identify which class or individual pesticide variables would have the most significant coefficients (lowest conditional p-value) if entered into the model. Then separate logistic models were built with the covariates and each of the ten pesticide variables with the lowest conditional p-values. Each of these models was examined to identify classes or individual pesticides that produced models with a lower log-likelihood value than that of the total pesticides model. The log-likelihood (or deviance) of a model is a measure of how well the model fits the data. Since the models all had the same number of parameters there was no need to account for model complexity (number of parameters) when comparing models (Harrell 2001). The

goal was not to select the single pesticide or pesticide class that produced the "best" model (lowest log likelihood), but rather to identify the set of pesticides or classes that best fit the data and produced a better fit than a total pesticides model. Just identifying and reporting the single best model might obscure a situation in which a number of pesticides or pesticide classes each were more or less equally associated with declines.

Results

Clearly multiple factors are contributing to amphibian declines. However, in the results and discussion that follows I focus only on the pesticide variables. For a full discussion of the multiple factors affecting these species as represented by the other model variables see (Davidson et al. 2002). Here other model variables (e.g., elevation, surrounding urbanization) are treated solely as covariates necessary to properly assess possible pesticide effects.

Total Pesticides Models

All four ranid frog species (*R. a. draytonii, R. boylii, R. cascadae,* and *R. muscosa*) showed a strong, statistically significant pattern of decline with greater amounts of total upwind pesticide use. In univariate analysis, total pesticide use and a number of covariates showed significant differences between present and absent sites for all species, except *B. canorus* (Table 1, and Fig. 2). The box plots show a striking pattern for all the ranid species. When upwind pesticide use is above a threshold value, sites are overwhelmingly

absent sites. At low levels of upwind pesticide use there are still many absent sites, consistent with multiple causes of decline, but the percentage of absent sites is substantially less than at higher levels.

Total pesticide use was a significant variable in the logistic regression models for all species, except *B. canorus* (Table 2). Total pesticide use had the largest standardized regression coefficient of all the variables in the model for *R. a. draytonii*, *R. boylii* and *R. cascadae*, and for *R. muscosa* the magnitude of the pesticide coefficient was equal with that of elevation, the only other variable in the model. The magnitude of the standardized coefficient for a variable indicates the how much the probability of a site having a present population (as measured by the log of the odds ratio) changes with a one standard deviation change of the variable, and is thus a way to compare the strength of association between the dependent variable (site status) and each of the independent variables.

In all five logistic regression models the likelihood-ratio test for the overall model was significant, the Hosmer-Lemeshow goodness-of-fit test (Hosmer & Lemeshow 1989) indicated the data fit the model and the models correctly classified population status for 64% (*B. canorus*) to 89% (*R. cascadae*) of all sites. The models all correctly classified better than a random model, however, the model for *R. muscosa* failed the stricter test of classification better than a naïve "majority rule." The *R. muscosa* model assigned all sites as absent, and since 83% of sites were absent the model "correctly" classified sites 83% of the time, even though it failed to distinguish between present and absent sites.

The model for *R. cascadae* was complicated by the fact that both latitude and upwind pesticide use were each highly significant in individual univariate tests, yet the two variables were fairly highly correlated for this species (Spearman correlation 0.74). There is a relatively small latitudinal difference (40 km) between the Lassen area, where the species has largely disappeared, and the Trinity Alps area, where the species is still common. I therefore modeled declines for *R. cascadae* with the upwind pesticide use variable and not latitude. Otherwise, pair wise spearman correlations of variables within species were generally below 0.5 suggesting that multicollinearity was not a problem in the logistic models. The one exception was a 0.7 correlation between latitude and precipitation in the *R. boylii* model. For the *R. boylii* model with both latitude and precipitation, variance inflation factors indicated no multicollinearity problem.

Pesticide Class Models

Application of the minimum use criteria for considering a pesticide class for multivariate modeling resulted in selection of 33 plausible pesticide classes for *B. canorus*, 55 for *R. a. draytonii*, 56 for *R. boylii*, 33 for *R. cascadae*, and 52 for *R. muscosa*. For each of the four ranid frogs a different set of pesticide classes produced regression models that fit the data better than a total pesticides model (Table 3). For *R. muscosa* all ten of the pesticides classes tested produced regression models with a lower log-likelihood than the total pesticides model. For *R. a. draytonii*, *R. boylii*, and *R. cascadae*, eight, three and two pesticide class models had a lower log-likelihood than the total pesticides model. For *Bufo canorus* no pesticide classes were significant. No single pesticide class stood out in the regression models as being most associated with declines, although many of the pesticide

class models were statistically significantly better than the respective total pesticides model for a species. The *R. cascadae* model was an exception in that none of the class models represented large improvements over the total pesticides model. The pesticide class N-methyl carbamates was noteworthy in that it produced a better model than did total pesticide for three of the ranid frogs and almost so for the forth (Table 3). Three other pesticide classes were among the top classes for two species: triazine, inorganics, and bipyridyliums.

Individual Pesticide Models

Application of the minimum use criteria for considering an individual pesticide for multivariate modeling resulted in selection of 91 plausible pesticides for *B. canorus*, 224 for *R. a. draytonii*, 214 for *R. boylii*, 94 for *R. cascadae*, and 165 for *R. muscosa*. For each species a different set of pesticides produced regression models that fit the data better than a total pesticides model (Table 4). Although neither total pesticides nor any of the pesticide classes were associated with *B. canorus* declines, two individual pesticides produced significant models: malathion and sodium chlorate. For *R. a. draytonii*, *R. boylii* and *R. muscosa* a large number of pesticides produced models with a lower log-likelihood than a total pesticides models. For *R. cascadae*, only malathion produced a better model, although a model with carbaryl was almost equivalent to the total pesticides model. For the four ranid frogs no single pesticide or set of pesticides stood out as either producing much better models than the total pesticide models, or of producing a better than total pesticides model for multiple species. The one exception was the pesticide carbaryl which produced a (slightly) better than total pesticides model for *R. a. draytonii*, *R. boylii*, *R.*

muscosa and almost so for *R. cascadae*. Three other pesticides (malathion, paraquat dichloride and sodium chlorate) each produced better than total pesticides models for two species.

Discussion

There is a strong association between declines and total upwind pesticide use for the four ranid frogs. In the total pesticides models, pesticides were the single strongest explanatory variable across the four frog species. These results represent, at a minimum, three independent tests of the association between total upwind pesticides and amphibian declines. The range of *R. a. draytonii* and *R. boylii* overlap by roughly two-thirds, and therefore could be considered a test for a single geographical area. However, there is virtually no overlap between the ranges of these two species and the ranges of *R. cascadae* and *R. muscosa*.

In the analysis of pesticide classes and individuals, no single class or pesticide emerged as most strongly associated with declines. Instead a different set of multiple classes and individual pesticides were associated with declines for each species. This could indicate that a wide range of pesticides are all contributing to declines. Although it is hard to imagine that pesticides as diverse as sulfur, sodium chlorate, and malathion are all acting in some similar fashion. Alternatively, one or a few pesticide classes or individual pesticides may actually be contributing to declines, but because of the high correlations between pesticide variables, multiple classes and individual pesticides are statistically

associated with declines. The only pesticide to stand out was carbaryl and its class N-methyl carbamates. A model with carbaryl fit the data better (although only slightly so) than a total pesticides model for *R. a. draytonii*, *R. boylii*, and *R. muscosa*, and produced a model equivalent to the total pesticides model for *R. cascadae*. N-methyl carbamates produced a better model than total pesticides for *R. a. draytonii*, *R. cascadae*, and *R. muscosa*, and a roughly equivalent model to the total pesticides model for *R. boylii*.

The covariates of elevation, latitude, precipitation, and surrounding urban and agricultural land use were chosen to control for the possible large scale spatial patterns of declines generated by habitat destruction (urbanization and agricultural conversion), climate change and ultraviolet-B radiation. If climate change or UV-B were strongly contributing to declines, one should see particular latitudinal and elevational gradients in declines. These gradients are not seen in the values of the elevation and latitude covariates, although the patterns of decline for R. boylii do show patterns suggestive of role for climate change. Two important factors that I was not able to include in the models are disease (for reviews see Carey et al. 1999; Daszak et al. 1999) and introduced species (e.g., Fisher & Shaffer 1996; Lawler et al. 1999; Knapp & Matthews 2000). I am currently working with others on a large-scale study of *R. muscosa* combining measurements of historic pesticide use with field observations of chytrid fungus disease outbreaks and introduced fish.

The statistical analysis presented here could be improved in two principal ways. First, further analysis should take account of possible spatial autocorrelation in the data. The

presence of spatial autocorrelation can bias coefficient variance estimates downward and thus produce false indications of significance (Legendre 1993). Second, the selection of classes and individual pesticides would be improved though the use of whole model Akaike Information Criteria (AIC) values as a selection criteria rather than p-values on the coefficients for individual pesticide or pesticide classes (Brunham & Anderson 2002). Although the two approaches likely produce similar results, the whole model AIC criteria would focus selection on pesticides that build the "best" models as measured by total model deviance.

Due to its large temporal and spatial scale the actual phenomenon of amphibian declines can never be directly subjected to experiments. For complex phenomenon that can not be experimented on, causality is not proven by a single study but rather inferred from the weight of the evidence from multiple studies, both observational and experimental. Therefore, observational studies will be key pieces of evidence in assessing the causes of declines. Epidemiologists have long struggled with how to infer causality from observational studies and multiple strands of evidence (Susser 1986; Fox 1991). Two of the key epidemiological criteria for inferring causality are strength of association and consistency of association. The results here show a strong association between upwind pesticide use and amphibian declines and the relationship is consistent across a number of different species.

The strong association between declines and upwind pesticide use clearly points to the urgent need for additional research on the role of pesticides in amphibian declines. Field

studies are needed to assess the types and amount of pesticide exposure for declining species. Several recent studies in the Sierra Nevada (Datta et al. 1998; Sparling et al. 2001) have documented current-use pesticide residues in the non-declining Pacific treefrog (*Hyla regilla*) and a 1970 study (Cory et al. 1970) found DDT in the bodies of *R. muscosa*. This work needs to be extended to current use pesticide residues in declining species. Secondly, laboratory experiments are needed to assess possible causal mechanisms of pesticide impacts at field relevant doses, and eventually on declining species.

Acknowledgments

I thank Haiganoush Preisler for statistical advice, Roland Knapp and David Bradford for data analysis suggestions, Arthur Lee and Tom Starbuck for database programming, Rudy Rull for help with DPR pesticide data, and Susan Kegley for sharing her pesticide classification scheme. Roland Knapp provided helpful comments on an earlier draft. Funding was provided by the U.S. Fish and Wildlife Service, Sacramento office, with special thanks to Maria Boroja.

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Table 1. Comparison of mean site characteristics for present sites versus absent sites.

Characteristic	*Bufo canorus*	*Rana aurora draytonii*	*Rana boylii*	*Rana cascadae*	*Rana muscosa*
Sites					
Total	55	279	424	70	255
Present	26	88	196	24	43
Absent	29	191	228	46	212
Percent absent	52	68	54	66	83
Total Pesticide Use[a]					
Present sites	9.8	60.0	46.4	5.7	23.2
Absent sites	18.9	137.5	187.9	71.4	66.4
P[b]	0.84	0.00	0.00	0.00	0.02
Latitude					
Present sites	37.75	36.43	39.35	41.21	37.91
Absent sites	37.88	36.11	37.68	40.38	37.87
P	0.29	0.13	0.00	0.00	0.73
Elevation (m)					
Present sites	2834	276	579	1651	2676
Absent sites	2420	445	521	1542	2253
P	0.10	0.00	0.12	0.54	0.00
Surrounding Urban[c]					
Present sites	0.00	0.07	0.04	0.01	0.00
Absent sites	0.01	0.10	0.05	0.01	0.00
P	0.12	0.02	0.00	0.04	0.16
Surrounding Ag[d]					
Present sites	0.00	0.09	0.04	0.00	0.00
Absent sites	0.00	0.13	0.15	0.00	0.00
P	0.34	0.12	0.00	0.20	0.19
Precipitation (cm)					
Present sites	44.3	23.2	48.1	54.5	46.2
Absent sites	44.3	21.0	27.9	56.5	44.9
P	0.73	0.11	0.00	0.65	0.58

[a] Total pesticide use is inverse distance weighted total pounds of active ingredients used upwind from a site.

[b] p value for Mann Whitney test of difference of means between present and absent sites.

[c] Percent urban land use in a 5-km radius surrounding a site.

[d] Percent agricultural land use in a 5-km radius surrounding a site.

Table 2. Logistic regression models using total pesticides.

Variable	B	S.E.	P	Exp(B)
Bufo canorus	G=71,p=0.024; C=6.37,p=0.087; Acc=63.6			
Elevation	0.689	0.337	0.041	1.991
Rana a. draytonii.	G=296.9,p<0.001; C=12.13,p=0.145; Acc=77.3			
Total pesticides	-0.946	0.229	<0.001	0.388
Elevation	-0.689	0.171	<0.001	0.502
% Urban 5 km circle	-0.568	0.173	0.001	0.567
Rana boylii	G=461,p<0.001; C=3.07,p=0.93; Acc=72.3			
Total pesticides	-0.758	0.176	<0.001	0.469
Latitude	0.656	0.145	<0.001	1.926
Precipitation	0.346	0.145	0.017	1.413
Rana cascadae	G=43.085,p<0.001; C=7.35,p=0.50; Acc=88.6			
Total pesticides	-5.124	1.449	<0.001	0.006
Elevation	1.055	0.476	0.027	2.873
Rana muscosa	G=212,p<0.001; C=9.93,p=0.27; Acc=83.1			
Total pesticides	-0.601	0.332	0.070	0.548
Elevation	0.607	0.189	0.001	1.835

The dependent variable for all models is frogs present (=1) or absent. G is the likelihood ratio test for overall model significance. C is the Hosmer-Lemeshow goodness of fit test. Acc is the percent of sites correctly classified as having present or absent populations. B is the standardized regression coefficient, and Exp(B) is the odds ratio. All model variables are significant based on likelihood ratio tests (not shown).

Table 3. Log-likelihood of pesticide class models

Species	Pesticide Class	LL
RAAD	Total Pesticides	296.9
RAAD	Other Carbamate	283.8
RAAD	Bipyridylium	286.2
RAAD	Cyclohexenone derivative	287.2
RAAD	Inorganic	288.6
RAAD	Phosphonoglycine	292.4
RAAD	2,6-Dinitroaniline	292.7
RAAD	Chlorophenoxy acid or ester	294.5
RAAD	N-Methyl Carbamate	294.8
RABO	Total Pesticides	453.0
RABO	Petroleum derivative	442.5
RABO	Fatty acids	448.0
RABO	Triazine	451.5
RABO	N-Methyl Carbamate	453.7
RACS	Total Pesticides	43.1
RACS	Inorganic-Copper	36.2
RACS	N-Methyl Carbamate	39.3
RAMU	Total Pesticides	212.2
RAMU	Chloroacetanilide	207.1
RAMU	Hydroxybenzonitrile	209.0
RAMU	Cyclohexenone derivative	208.7
RAMU	Aryloxyphenoxy propionic acid	208.0
RAMU	Bipyridylium	210.6
RAMU	Inorganic	210.8
RAMU	Alcohol/Ether	211.3
RAMU	Triazine	211.7
RAMU	N-Methyl Carbamate	211.7
RAMU	Organochlorine	211.0

[a] RAAD is *Rana aurora draytonii*, RABO is *R. boylii*, RACS is *R. cascadae*, RAMU is *R. muscosa*.

[b] LL is the model log-likelihood or deviance. All models are with the same covariates as in total pesticides models. Only class models with a lower deviance than the total pesticides model are shown, with the exception of N-methyl Carbamate for *R. boylii* which is included for comparison.

Table 4. Log-likelihood of individual pesticide models

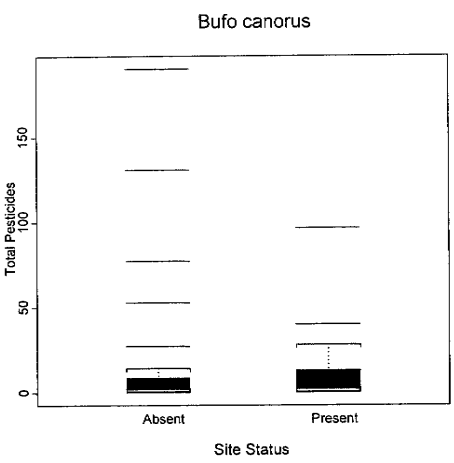
Species[a]	Pesticide	Pesticide Class	LL[b]
BUCA	Elevation only		71.0
BUCA	Sodium chlorate	Inorganic	61.3
BUCA	Malathion	Organophosphorus	65.9
RAAD	Total Pesticides		296.9
RAAD	Paraquat dichloride	Bipyridylium	285.7
RAAD	Sodium chlorate	Inorganic	288.4
RAAD	Carbofuran	N-Methyl Carbamate	288.5
RAAD	Sulfur	Inorganic	290.3
RAAD	Dichlofenthion	Organophosphorus	292.4
RAAD	Glyphosate, isopropylamine salt	Phosphonoglycine	292.4
RAAD	2,4-D, dimethylamine salt	Chlorophenoxy acid or ester	292.8
RAAD	Napropamide	Amide	295.3
RAAD	Carbaryl	N-Methyl Carbamate	295.7
RABO	Total Pesticides		452.9
RABO	Copper oxychloride sulfate	Inorganic-Copper	445.0
RABO	Ethion	Organophosphorus	446.5
RABO	Hexachlorophene	Chlorinated Phenol	443.9
RABO	Petroleum oil, unclassified	Petroleum derivative	443.9
RABO	Bis(tributyltin) succinate	Organotin	452.2
RABO	Copper sulfate (basic)	Inorganic-Copper	452.2
RABO	Oleic acid	Fatty acids	447.9
RABO	Carbaryl	N-Methyl Carbamate	451.2
RACS	Total Pesticides		43.1
RACS	Carbaryl	N-Methyl Carbamate	43.5
RACS	Malathion	Organophosphorus	40.5

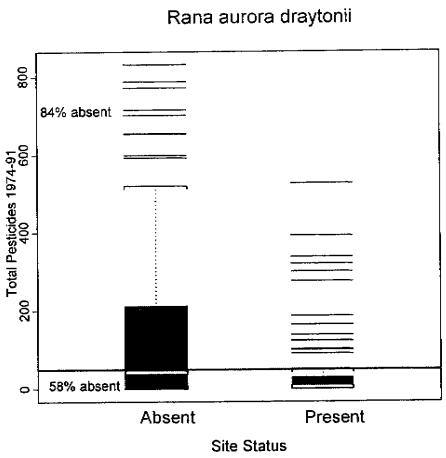
RAMU	Total Pesticides		212.2
RAMU	1,2-dichloropropane, 1,3-dichlor-opropene, related C3 compounds	Halogenated organic	207.8
RAMU	Metolachlor	Chloroacetanilide	206.1
RAMU	Butylate	Thiocarbamate	206.4
RAMU	Bromoxynil octanoate	Hydroxybenzonitrile	209.0
RAMU	Sethoxydim	Cyclohexenone derivative	208.7
RAMU	Acephate	Organophosphorus	211.3
RAMU	Paraquat dichloride	Bipyridylium	210.6
RAMU	Phosalone	Organophosphorus	211.3
RAMU	Prometryn	Triazine	209.2
RAMU	1,3-dichloropropene	Halogenated organic	211.0
RAMU	Carbaryl	N-Methyl Carbamate	211.4

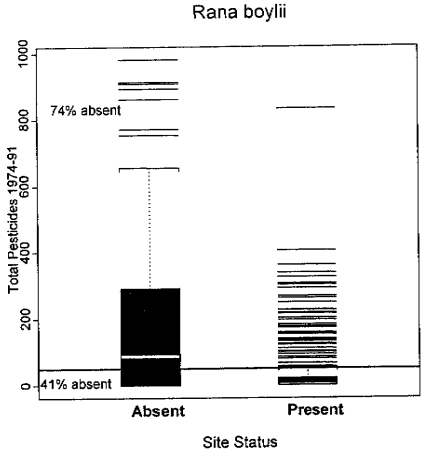
[a] BUCA is Bufo canorus, RAAD is Rana aurora draytonii, RABO is *R. boylii*, RACS is *R. cascadae*, RAMU is *R. muscosa*.

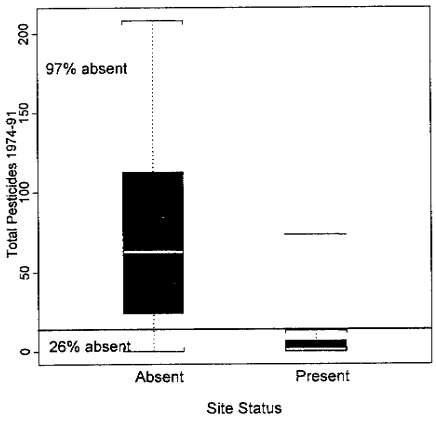
[b] LL is the model log-likelihood or deviance. All models are with the same covariates as in total pesticides models, except for the *B. canorus* model. For that species total pesticides was not a significant variable, only the covariate elevation was significant, and it is included in the two individual pesticide models for the species. Only pesticide models with a lower deviance than the total pesticides model are shown, with the exception of carbaryl for *R. cascadae* which is included for comparison.

Figure 1. Illustration of upwind pesticide use measurements. For each amphibian site, a 22.5^{o}, 100-km long, "upwind triangle" was drawn facing into the direction of the predominant wind. Total pesticide use was calculated as the sum of the total weight of active ingredients of pesticides applied in a section from 1974 to 1991 for every other year, divided by the distance from the section centroid to the amphibian site (d) for all public land system section falling at least partly within the upwind triangle. Similar measures were calculated for pesticide classes and individual pesticides.


Bufo canorus
Total Pesticides
0
50
100
150
Absent
Present
Site Status


Rana aurora draytonii
Total Pesticides 1974-91
0
200
400
600
800
84% absent
58% absent
Absent
Present
Site Status


Rana boylii
Total Pesticides 1974-91
0
200
400
600
800
1000
74% absent
41% absent
Absent
Present
Site Status


Rana cascadae
Total Pesticides 1974-91
0
50
100
150
200
97% absent
26% absent
Absent
Present
Site Status

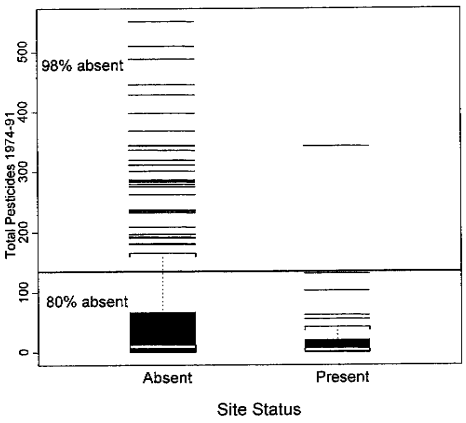
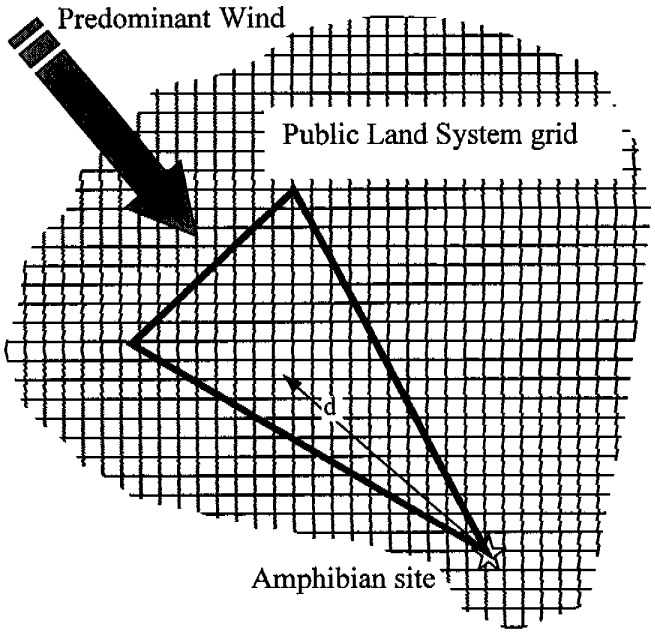

Rana muscosa
Total Pesticides 1974-91
0
100
200
300
400
500
98% absent
80% absent
Absent
Present
Site Status

Figure 2. Box plots of the distribution of total upwind pesticide use for present and absent sites for five species of declining amphibians. The horizontal line across a plot indicates the pesticide level that maximized the difference between the percent of total sites that are absent at higher pesticide levels versus at lower pesticide levels. For example, for *R. a. draytonii* at sites with pesticide levels above the line 84% are absent sites, while at sites with pesticide levels below the line, 58% of the sites are absent sties. The cutoff levels for each species were determined by univariate tree regression with status as the dependent variable and total pesticide use as the independent variable.


Predominant Wind
Public Land System grid
d
Amphibian site

Appendix A. Pesticide Classification and Historic Use

The following table gives individual pesticide names, pesticide classes and pounds of total use in the 1974-1991 dataset. Pesticide classifications are from Orme and Kegley (2002). The class "unclassified" includes pesticides that do not fit into any of the other classes. The class "No class" includes pesticides that have yet to be classified.

pan_classname	chem_name	Pounds
1,3-Indandione	Pindone, sodium salt	0.000
1,3-Indandione	2-isovaleryl 1-1,3-indandione, calcium salt	1.744
1,3-Indandione	Diphacinone	12.575
1,3-Indandione	Diphacinone, sodium salt	0.001
1,3-Indandione	Pindone	2.796
1,3-Indandione	Chlorophacinone	53.382
2,6-Dinitroaniline	Pendimethalin	1,271,851.803
2,6-Dinitroaniline	Trifluralin	3,806,361.564
2,6-Dinitroaniline	Dinitramine	97,501.200
2,6-Dinitroaniline	Oryzalin	947,593.216
2,6-Dinitroaniline	Nitralin	101,782.901
2,6-Dinitroaniline	Ethalfluralin	65,061.618
2,6-Dinitroaniline	Benfluralin	374,042.792
2,6-Dinitroaniline	Profluralin, other related	4,778.716
2,6-Dinitroaniline	Butralin	543.593
2,6-Dinitroaniline	Fluchloralin	16,551.662
2,6-Dinitroaniline	Profluralin	105,869.845
Alcohol/Ether	Ethyl alcohol	12.849
Alcohol/Ether	Alcohols, C4-C12, normal	12.731
Alcohol/Ether	Ethylene oxide	4.500
Alcohol/Ether	Butyl alcohol	6,337.000
Alcohol/Ether	Alkylaryl polyether alcohol	40,546.968
Alcohol/Ether	Methanol	86.366
Alcohol/Ether	Isopropyl alcohol	420,638.118
Alcohol/Ether	Propylene oxide	19,987.000
Aldehyde	Acrolein	136,523.671
Aldehyde	Metaldehyde	85,008.003
Alkyl Phthalate	Isooctyl phthalate	72.146
Alkyl Phthalate	Chlorthal-dimethyl	5,180,183.968
Alkyl Phthalate	Di-n-octyl phthalate	29,816.767
Amide	Naptalam, sodium salt	17,744.022
Amide	Diphenamid	434,551.504
Amide	Napropamide	884,288.892
Amide	Propyzamide	834,688.116
Amide	Allidochlor	41.620
Anilide	Mefluidide, diethanolamine salt	259.116
Anilide	Propanil	704,724.415
Anilide	Cypromid	339.999
Animal derived	Calcium salts of casein and soy	144.991
Animal derived	Putrescent whole egg solids	549.008
Animal derived	Casein	9,264.539
Animal derived	Dry milk solids	57.398
Aryloxyphenoxy propionic acid	Fluazifop-butyl	36,308.258
Aryloxyphenoxy propionic acid	Diclofop-methyl	266,429.332
Azole	Triadimefon	255,214.935
Azole	Myclobutanil	52,601.564
Azole	Paclobutrazol	0.476
Azole	Terrazole	50,817.702
Azole	Imazalil	18,840.786
Azole	Triflumizole	5.000
Benzimidazole	Thiabendazole	7,415.860
Benzimidazole	Thiabendazole, hypophosphite salt	0.340
Benzimidazole	Benomyl	1,227,349.100

pan_classname	chem_name	Pounds
Benzimidazole	2-EEEBC	0.001
Benzimidazole	Thiophanate	5,152.366
Benzimidazole precursor	Thiophanate-methyl	297,387.929
Benzoic acid	Dicamba	349.308
Benzoic acid	Dicamba, dimethylamine salt, other related	32,478.081
Benzoic acid	Dicamba, other related	0.197
Benzoic acid	Chloramben	807.839
Benzoic acid	Dicamba, dimethylamine salt	174,373.702
Benzoic acid	Dicamba, diethanolamine salt	27.968
Benzoic acid	Chloramben, ammonium salt	15,701.979
Benzoic acid	Chloramben, ammonium salt, other related	1,133.843
Benzoic acid	Benzoic acid	3,420.524
Benzoylurea	Diflubenzuron	4,454.358
Bipyridylium	Paraquat dichloride	6,694,011.961
Bipyridylium	Paraquat bis(methylsulfate)	72,572.178
Bipyridylium	Diquat dibromide	196,938.754
Bis-Carbamate	Phenmedipham	86,534.088
Bis-Carbamate	Desmedipham	41,888.681
Botanical	IBA	6.094
Botanical	Rotenone	5,693.908
Botanical	Rotenone, other related	5,412.241
Botanical	Ryanodine alkaloid	253.350
Botanical	Sabadilla alkaloids	2,839.971
Botanical	Sawdust	17.468
Botanical	Cottonseed flour	18,574.256
Botanical	Gibberellins, potassium salt	821.497
Botanical	Pine oil	0.105
Botanical	Garlic	3,451.155
Botanical	Pyrethrins	11,181.254
Botanical	Cube extracts	2,492.179
Botanical	Red squill glycoside	1.350
Botanical	Corn product, hydrolyzed	8,598.929
Botanical	Xanthan gum	19.337
Botanical	Pinene	0.081
Botanical	Capsicum oleoresin	8,532.372
Botanical	Gibberellins	215,356.387
Botanical	1-Naphthaleneacetamide (NAD)	89.711
Botanical	Beta-caryophyllene	0.081
Botanical	Tall oil acids	1,703.288
Botanical	Synthetic vegetable gums	290.507
Botanical	Strychnine	24,729.862
Botanical	Strychnine sulfate	51.806
Botanical	Avermectin	3,403.310
Botanical	Nicotine	3,386.754
Carbohydrate	Lactose	13,396.694
Carbohydrate	Sorbitol	6,359.564
Carbohydrate	Molasses	435.004
Carbohydrate	Polysaccharide polymer	254.386
Carbohydrate	Sugar	9,506.629
Carboxamide	Carboxin	6,891.284
Carboxamide	Oxycarboxin	2,016.906
Cellulose derivative	Methyl cellulose	6,904.902
Chelating agent	EDTA, tetrasodium salt	1,590.781

pan_classname	chem_name	Pounds
Chelating agent	EDTA, trisodium salt	1.605
Chelating agent	EDTA	4.644
Chelating agent	N-(2-hydroxyethyl) ethylene diamine triacetic acid,trisodium	34.456
Chelating agent	EDTA, sodium salt	525.079
Chlorinated Phenol	PCP, sodium salt, other related	204.600
Chlorinated Phenol	PCP, sodium salt	1,469.400
Chlorinated Phenol	PCP, other related	2,042.114
Chlorinated phenol	Ortho-benzyl-para-chlorophenol, potassium salt	201.393
Chlorinated phenol	Ortho-benzyl-para-chlorophenol, sodium salt	274.610
Chlorinated Phenol	PCP	17,587.788
Chlorinated phenol	Ortho-benzyl-para-chlorophenol	71.644
Chlorinated Phenol	Hexachlorophene, sodium salt	8,762.016
Chlorinated Phenol	Dichlorophene	263,650.865
Chloroacetanilide	Alachlor	681,975.642
Chloroacetanilide	Metolachlor	256,842.166
Chloroacetanilide	Propachlor	9,016.995
Chloroacetanilide	Diethatyl-ethyl	196,487.654
Chlorophenoxy acid or ester	MCPA, dimethylamine salt	4,353,682.004
Chlorophenoxy acid or ester	MCPP	79.486
Chlorophenoxy acid or ester	MCPA, isooctyl ester	126,563.832
Chlorophenoxy acid or ester	2,4,5-T, butoxyethanol ester	1,198.371
Chlorophenoxy acid or ester	Dichlorprop, butoxyethanol ester	12,957.442
Chlorophenoxy acid or ester	2,4-DP, isooctyl ester	1.541
Chlorophenoxy acid or ester	2,4-DP, diethanolamine salt	18.889
Chlorophenoxy acid or ester	MCPA, butoxyethanol ester	20,091.815
Chlorophenoxy acid or ester	MCPB, sodium salt	2,836.571
Chlorophenoxy acid or ester	MCPA, sodium salt	196,238.172
Chlorophenoxy acid or ester	MCPA, alkanolamine salt	49,870.999
Chlorophenoxy acid or ester	MCPP, diethanolamine salt	395.478
Chlorophenoxy acid or ester	MCPP, dimethylamine salt	16,032.159
Chlorophenoxy acid or ester	2,4,5-T, alkylamine salt	7.046
Chlorophenoxy acid or ester	2,4,5-T, dodecylamine salt	0.760
Chlorophenoxy acid or ester	2,4,5-T, isooctyl ester	1,397.827
Chlorophenoxy acid or ester	MCPP, potassium salt	554.733
Chlorophenoxy acid or ester	2,4,5-T, propylene glycol butyl ether ester	20,553.974
Chlorophenoxy acid or ester	2,4,5-T tetradecylamine salt	0.190
Chlorophenoxy acid or ester	2,4,5-T, triethylamine salt	2,209.443
Chlorophenoxy acid or ester	4-(2,4-DB), butoxyethanol ester	74,776.755
Chlorophenoxy acid or ester	4(2,4-DB), dimethylamine salt	356,996.402
Chlorophenoxy acid or ester	2,4,5-T, 2-ethylhexyl ester	21.335
Chlorophenoxy acid or ester	2,4-D, butyl ester	25,688.725
Chlorophenoxy acid or ester	2,4-D, isooctyl ester	223,817.305
Chlorophenoxy acid or ester	Silvex	365.368
Chlorophenoxy acid or ester	Silvex , 2-ethylhexyl	5.665
Chlorophenoxy acid or ester	Silvex, butoxyethanol ester	94,247.203
Chlorophenoxy acid or ester	Silvex, butoxypropyl ester	3,998.094
Chlorophenoxy acid or ester	Silvex, isooctyl ester	649.975
Chlorophenoxy acid or ester	Silvex, propylene glycol butyl ether ester	27,458.848
Chlorophenoxy acid or ester	2,4-D, heptylamine salt	25.524
Chlorophenoxy acid or ester	2,4-D, isopropyl ester	12,073.750
Chlorophenoxy acid or ester	2,4-D, dimethylamine salt	3,925,599.745
Chlorophenoxy acid or ester	2,4-D, diethanolamine salt	80,629.020
Chlorophenoxy acid or ester	2,4-D, butoxypropyl ester	39,699.738

pan_classname	chem_name	Pounds
Chlorophenoxy acid or ester	2,4-D, butoxyethanol ester	453,850.689
Chlorophenoxy acid or ester	Erbon	5.940
Chlorophenoxy acid or ester	2,4-D, triisopropylamine salt	1,794.884
Chlorophenoxy acid or ester	2,4-DB, isooctyl ester	136,147.339
Chlorophenoxy acid or ester	2,4-D, alkanolamine salts (ethanol and isopropanol amines	1,181,297.736
Chlorophenoxy acid or ester	2,4-D	492,347.133
Chlorophenoxy acid or ester	2,4-D, 2-ethylhexyl ester	46,551.299
Chlorophenoxy acid or ester	2,4-D, dodecylamine salt	116,357.473
Chlorophenoxy acid or ester	2,4-D, sodium salt	24,667.178
Chlorophenoxy acid or ester	2,4-D, propylene glycol butyl ether ester	614,299.930
Chlorophenoxy acid or ester	2,4-D, propyl ester	75,210.480
Chlorophenoxy acid or ester	2,4-D, N-oleyl-1,3-propylenediamine salt	263,357.685
Chlorophenoxy acid or ester	2,4-D, tetradecylamine salt	28,946.072
Chlorophenoxy acid or ester	2,4-D, N,N-dimethyl oleyl-linoleylamine salt	4,476.472
Chlorophenoxy acid or ester	2,4-D, triethylamine salt	127,879.729
Chloropyridinyl	Triclopyr, triethylamine salt	2,478.158
Chloropyridinyl	Triclopyr, butoxyethyl ester	74,246.989
Coumarin	Bromadiolone	0.042
Coumarin	Brodifacoum	0.302
Coumarin	Coumafuryl	1.337
Coumarin	Warfarin	0.859
Cyclohexenone derivative	Sethoxydim	94,284.602
Dicarboximide	N-octyl bicycloheptene dicarboximide	7.500
Dicarboximide	Vinclozolin	152,300.629
Dicarboximide	Iprodione	725,558.361
Dinitrophenol derivative	DNOC, sodium salt	1,488.759
Dinitrophenol derivative	Dinoseb, ammonium salt	112,615.915
Dinitrophenol derivative	Dinoseb	6,717,175.079
Dinitrophenol derivative	Dinoseb, triethanolamine salt	12,687.198
Dinitrophenol derivative	Dinoseb, amine salt	982,310.592
Dinitrophenol derivative	Dinocap, other related	89.990
Dinitrophenol derivative	Dinocap	18,010.303
Dinitrophenol derivative	Binapacryl	742.000
Diphenyl ether	Nitrofen	1,162,113.317
Diphenyl ether	Oxyfluorfen	565,273.281
Diphenyl ether	Bifenox	177.492
Dithiocarbamate	Thiram	126,263.794
Dithiocarbamate	Sulfallate	567,866.417
Dithiocarbamate	Metiram	159,978.000
Dithiocarbamate	Maneb	4,889,801.310
Dithiocarbamate	Mancozeb	2,716,771.799
Dithiocarbamate	Zineb	205,837.499
Dithiocarbamate	Ferbam	63,502.247
Dithiocarbamate	Ziram	6,862,914.175
Dithiocarbamate	Metam-sodium	5,002,159.569
Dithiocarbamate	Nabam	7,402.003
Fatty acids	Oleic acid	57,278.157
Formamidine	Chlordimeform	457,631.228
Formamidine	Chlordimeform hydrochloride	64,109.849
Formamidine	Amitraz	31,772.925
Glycol	Propylene glycol	90,745.646
Glycol Ether	Glycol ethers	525.363
Guanidine	Dodine	27,962.423

pan_classname	chem_name	Pounds
Halogenated organic	DBCP	1,766,138.191
Halogenated organic	Ethylene dichloride	30,061.917
Halogenated organic	Methyl bromide	71,132,558.140
Halogenated organic	1,3-dichloropropene	48,981,276.274
Halogenated organic	Carbon tetrachloride	82,312.063
Halogenated organic	DBCP, other related	22,664.784
Halogenated organic	Para-dichlorobenzene	0.500
Halogenated organic	Ethylene dibromide	5,073,165.960
Halogenated organic	1,2-dichloropropane, 1,3-dichloropropene and related C3 c	81,154,414.002
Hydantoin	1-bromo-3-chloro-5,5-dimethyl hydantoin	203.980
Hydroxybenzonitrile	Bromoxynil octanoate	1,206,619.476
Hydroxybenzonitrile	Bromoxynil butyrate	17,424.624
Inorganic	Monosodium phosphate	113.702
Inorganic	Borax	743.565
Inorganic	Carbon disulfide	116,300.024
Inorganic	Calcium hypochlorite	1,582.363
Inorganic	Calcium chloride	8,614.323
Inorganic	Carbon	1,147.349
Inorganic	Urea dihydrogen sulfate	8,308.257
Inorganic	Calcium carbonate	79,925.855
Inorganic	Tetrapotassium pyrophosphate	3,976.920
Inorganic	Calcium hydroxide	4,337,376.430
Inorganic	Urea	48,414.583
Inorganic	Calcium cyanide	0.007
Inorganic	Bentonite	202,289.690
Inorganic	Calcium thiosulfate	3.382
Inorganic	Boric acid	550.722
Inorganic	Trisodium phosphate	4,070.619
Inorganic	Manganese sulfate	19,323.432
Inorganic	Sodium carbonate	0.255
Inorganic	Magnesium sulfate	19,468.719
Inorganic	Sodium nitrate	2,221.061
Inorganic	Ammonium sulfate	2,038.120
Inorganic	Sodium metasilicate	0.148
Inorganic	Sodium metaborate	5,521.480
Inorganic	Sodium hypochlorite	8,358.041
Inorganic	Sodium hydroxide	3,313.909
Inorganic	Phosphoric acid	308,460.105
Inorganic	Phosphorus	16.128
Inorganic	Hydrogen chloride	48.078
Inorganic	Sodium chlorate	36,485,864.123
Inorganic	Sodium polysulfide	29,131.700
Inorganic	Aluminum sulfate	6,155.110
Inorganic	Aluminum phosphide	445,925.395
Inorganic	Ferrous sulfate	18,522.974
Inorganic	Silica aerogel	495.958
Inorganic	Ferric sulfate (anhydrous)	13.959
Inorganic	Chlorine	146,814.740
Inorganic	Potassium hydroxide	1,357.703
Inorganic	Potassium nitrate	30.501
Inorganic	Cryolite	11,111,431.602
Inorganic	Sodium cyanide	36.116
Inorganic	Lime-sulfur	689,878.509

pan_classname	chem_name	Pounds
Inorganic	Sulfuryl fluoride	148.500
Inorganic	Sodium molybdate	1,108.203
Inorganic	Lime	4,638.451
Inorganic	Sodium tetrathiocarbonate	10,617.404
Inorganic	Sulfuric acid	1,436,998.459
Inorganic	Sulfur	56,257,931.960
Inorganic	Magnesium chloride	30.086
Inorganic	Ammonium sulfamate	12,117.250
Inorganic	Magnesium phosphide	2,793.769
Inorganic	Ammonia	605.890
Inorganic	Diammonium phosphate	50,571.986
Inorganic	Sodium tripolyphosphate	14.106
Inorganic	Sodium thiosulfate	2,894.700
Inorganic	Sulfur dioxide	149,569.940
Inorganic-arsenic	Lead arsenate	73,482.209
Inorganic-arsenic	Calcium arsenate	15,085.362
Inorganic-arsenic	Arsenic pentoxide	7,670.912
Inorganic-arsenic	Sodium arsenate	163,007.724
Inorganic-arsenic	Lead arsenate, basic	264,621.026
Inorganic-arsenic	Arsenic acid	18,332.355
Inorganic-arsenic	Sodium arsenite	930,085.568
Inorganic-Cadmium	Cadmium chloride	2.161
Inorganic-Cadmium	Cadmium sebacate	2.150
Inorganic-Cadmium	Cadmium succinate	0.375
Inorganic-Chromium(VI)	Potassium chromate	2.150
Inorganic-Chromium(VI)	Chromic acid	10,716.715
Inorganic-Copper	Lignin sulfonic acid, copper salt	538.064
Inorganic-Copper	Copper ammonium carbonate	3,742.429
Inorganic-Copper	Copper oxychloride sulfate	2,073,499.643
Inorganic-Copper	Copper carbonate, basic	55,871.006
Inorganic-Copper	Copper ammonium complex	48,220.347
Inorganic-Copper	Copper sulfate (pentahydrate)	9,408,775.538
Inorganic-Copper	Copper dihydrazinium sulfate	11,444.080
Inorganic-Copper	Copper ethanolamine complexes, mixed	1,023.548
Inorganic-Copper	Copper sulfate, monohydrate	8,012.504
Inorganic-Copper	Copper hydroxide	7,574,113.816
Inorganic-Copper	Copper sulfate (basic)	4,868,170.454
Inorganic-Copper	Copper oxychloride	84,227.463
Inorganic-Copper	Copper oxide (ic)	3,409.643
Inorganic-Copper	Copper oleate	1.369
Inorganic-Copper	Copper hydroxide - triethanolamine complex	35,411.182
Inorganic-Copper	Copper naphthenate	62.559
Inorganic-Copper	Copper sulfate (anhydrous)	3,443.315
Inorganic-Copper	Copper sodium sulfate-phosphate complex	0.342
Inorganic-Copper	Copper salts of fatty and rosin acids	141,647.227
Inorganic-Copper	Copper	945,108.137
Inorganic-Copper	Copper oxide (ous)	332,495.690
Inorganic-Mercury	Calomel	66.561
Inorganic-Mercury	Mercuric chloride	33.287
Inorganic-Zinc	Copper-zinc sulfate complex, monohydrate	3,522.000
Inorganic-Zinc	Copper-zinc sulfate complex	755,716.823
Inorganic-Zinc	Zinc sulfate	81,912.135
Inorganic-Zinc	Zinc phosphide	21,629.064

pan_classname	chem_name	Pounds
Inorganic-Zinc	Lignin sulfonic acid, zinc salt	2,598.393
Inorganic-Zinc	Lignin sulfonic acid, zinc, manganese & iron salts	2,834.165
Iodine Compound	Nonyl phenoxy polyoxyethylene ethanol-iodine complex	145.265
Mercaptobenzothiazole	TCMTB	17,507.551
Microbial	Polyhedral inclusion bodies of Douglas fir tussock moth nu	11.806
Microbial	Bacillus thuringiensis (berliner), subsp. Israelensis, serotyp	249.364
Microbial	Bacillus thuringiensis (berliner), subsp. Kurstaki, strain SA-	15,026.169
Microbial	Agrobacterium radiobacter	0.203
Microbial	Bacillus thuringiensis (berliner), subsp. Kurstaki, serotype 3	25,355.088
Microbial	Bacillus thuringiensis (berliner)	145,388.648
Microbial	Encapsulated delta endotoxin of Bacillus thuringiensis var.	34.986
Microbial	Nosema locustae spores	0.013
Microbial	Bacillus thuringiensis (berliner), subsp. Kurstaki, strain EG2	1,391.713
Morpholine	Dodemorph acetate	21,111.258
Naphthalene acetic acid derivative	NAA, sodium salt	1.050
Naphthalene acetic acid derivative	NOA	0.035
Naphthalene acetic acid derivative	1-Naphthaleneacetic acid, methyl ester	0.001
Naphthalene acetic acid derivative	NAA	2.304
Naphthalene acetic acid derivative	NAA, ammonium salt	5,450.456
Naphthalene acetic acid derivative	NAA, ethyl ester	544.874
Naphthalene acetic acid derivative	NAA, potassium salt	4,662.896
Naphthalene acetic acid derivative	2-methyl-1-naphthalene acetamide	0.001
N-Methyl Carbamate	Propoxur	1,433.346
N-Methyl Carbamate	Pirimicarb	515.141
N-Methyl Carbamate	Bendiocarb	4,668.650
N-Methyl Carbamate	Oxamyl	203,188.759
N-Methyl Carbamate	Methomyl	9,721,058.278
N-Methyl Carbamate	Formetanate hydrochloride	1,237,066.471
N-Methyl Carbamate	Bufencarb	320,483.460
N-Methyl Carbamate	Mexacarbate	140.460
N-Methyl Carbamate	Methiocarb	57,795.127
N-Methyl Carbamate	Carbaryl	8,437,735.368
N-Methyl Carbamate	Carbofuran	2,087,322.248
N-Methyl Carbamate	Aldicarb	2,632,039.477
NoClass	Rosins and fatty acids, mixed	3,746.481
NoClass	Flurenol-methyl	0.003
NoClass	Alkylaryl sulfonates	60.842
NoClass	Sodium alkylaryl sulfonate	578.262
NoClass	Fenac, ammonium salt	31.053
NoClass	Fatty acids, methyl esters	943.349
NoClass	Ethylan, other related	7,453.463
NoClass	Polyhydric alcohols	898.893
NoClass	Dichlone	12,365.555
NoClass	Ethylene diamine acetate	7.910
NoClass	Potassium resinate	15.213
NoClass	Fenac, sodium salt	1.679
NoClass	Fatty acids, mixed	1,759.588
NoClass	Fatty acid and phosphatic	912.210
NoClass	Fenaminosulf	192.525
NoClass	Chlorflurenol, methyl ester	0.014
NoClass	Potassium abeitate	100.519
NoClass	Alpha-alkyl (C10-C14)-omega-hydroxypoly (oxyethylene)	152.524
NoClass	Triethanolamine sulfonate	9.865

pandclassname	chem_name	Pounds
NoClass	2,3,6-TBA, dimethylamine salt, other related	96.400
NoClass	Auramine	0.215
NoClass	Dodecyl phenoxy benzene sulfonic acid, sodium salt	329.334
NoClass	2-(2-butoxy ethoxy) ethyl thiocyanate	0.107
NoClass	Dimethipin	37.308
NoClass	Diiodomethyl p-tolyl sulfone	0.938
NoClass	Triethanolamine	10,191.923
NoClass	Diglycerides of fatty acids	3,076.535
NoClass	Tris (hydroxymethyl) nitromethane	627.878
NoClass	Dimethoxane	112.923
NoClass	Dioctyl sodium sulfosuccinate (octyl is 2-ethylhexyl)	19,789.162
NoClass	Dioctyl sodium sulfosuccinate	9,019.836
NoClass	1080	176.614
NoClass	Calcium cyanamide	22,347.160
NoClass	Azacosterol	0.050
NoClass	Sulfanilamide	0.003
NoClass	Sodium sulforicinoleate	1,069.664
NoClass	Sorbic acid	12.122
NoClass	Sorbitan fatty acid ester	7.991
NoClass	Erbon, other related	2.040
NoClass	Soybean fatty acids, dimethylamine salt	4,410.094
NoClass	2-ethylhexyl sulfuric acid, sodium salt	522.248
NoClass	Diethylene glycol abietate	8.451
NoClass	Ethoxylated amines	336.280
NoClass	Sulfaquinoxaline	0.474
NoClass	Aramite	0.188
NoClass	Sulfonated alkyldiphenyl oxide	1.230
NoClass	2,3,6-TBA, dimethylamine salt	145.527
NoClass	Coconut diethanolamide	24.166
NoClass	Tetradifon	11,260.104
NoClass	Streptomycin	14,032.086
NoClass	Lignin sulfonic acid, iron salt	677.063
NoClass	Kinoprene	1,487.804
NoClass	Linolenic acid	67.032
NoClass	Linoleic acid	279.299
NoClass	Oxyalkylated alcohol	5,745.960
NoClass	Lignin sulfonic acid, metal salts	7,729.194
NoClass	Citric acid	17,401.455
NoClass	Acetic acid	3.654
NoClass	Piperonyl butoxide, technical, other related	15,276.800
NoClass	Alcohol sulfates	378.881
NoClass	Oxytetracycline hydrochloride	7,243.552
NoClass	Lignin sulfonic acid, calcium salt	3,057.846
NoClass	Lignin sulfonic acid	19,595.260
NoClass	Dextrin	1.356
NoClass	Lanolin	21.175
NoClass	Alkyl sulfate, sodium salt	10.227
NoClass	Lignin sulfonic acid, manganese salt	49.835
NoClass	Methoprene	188.146
NoClass	Alkyl benzene sulfonic acid	8,188.876
NoClass	Cresylic acid	674.125
NoClass	Morpholine	12,928.925
NoClass	Methylated naphthalene	73.365

pan_classname	chem_name	Pounds
NoClass	Methyl-2,3-dichloro-9-hydroxyfluorene-9-carboxylate	0.003
NoClass	N-(phenylmethyl)-9-(tetrahydro-2H-pyran-2-yl)-9H-purin-6-a	0.026
NoClass	Oxadiazon	7,547.074
NoClass	N6-benzyl adenine	3.688
NoClass	Lignin sulfonic acid, magnesium salt	45.044
NoClass	Dalapon	1,744.149
NoClass	Dalapon, magnesium salt	12,573.253
NoClass	Benzyldiethyl [(2,6-xylylcarbamoyl)methyl] ammonium sacc	0.001
NoClass	Daminozide	14,327.005
NoClass	Nitrapyrin	3,476.381
NoClass	Nitrapyrin, other related	387.129
NoClass	Cycloheximide	155.107
NoClass	Abietic anhydride	8.451
NoClass	Coconut oil amine acetate	58.324
NoClass	Glycerol	147.014
NoClass	Glutaraldehyde	56.628
NoClass	Hexahydric alcohol	552.458
NoClass	4-aminopyridine	7.349
NoClass	a-(p-(1,1,3,3-tetramethyl butyl) phenyl)-omega-hydroxy poly	5.172
NoClass	Clofentezine	4.599
NoClass	Condensates of alkyl oxides	53.827
NoClass	Phoston	366.833
NoClass	Dialkyl benzene dicarboxylate	465.293
NoClass	2,6-dinitro-4-octylphenyl crotonate	2.118
NoClass	Parinol	0.626
NoClass	3-chloro-p-toluidine hydrochloride	33.387
NoClass	Fosamine, ammonium salt	303.202
Oil - essential	Limonene	0.081
Oil - essential	Essential oils	0.000
Oil - vegetable	Cottonseed oil	309,647.290
Oil - vegetable	Safflower oil	7.999
Oil - vegetable	Vegetable oil	236,253.811
Organoarsenic	Calcium acid methanearsonate	5,806.876
Organoarsenic	Octylammonium methanearsonate	8.104
Organoarsenic	Cacodylic acid	220,161.204
Organoarsenic	MSMA	235,933.569
Organoarsenic	DSMA	121,523.356
Organoarsenic	Dodecyl ammonium methanearsonate	8.104
Organoarsenic	Sodium cacodylate	1,282,629.549
Organochlorine	Methoxychlor	544,191.406
Organochlorine	Dieldrin	60,744.941
Organochlorine	Aldrin, other related	1.176
Organochlorine	Dienochlor	19,241.505
Organochlorine	Ethylan	175,342.960
Organochlorine	Chlordane	426,276.818
Organochlorine	Aldrin	22,538.229
Organochlorine	alpha-BHC	562.032
Organochlorine	Chlordane, other related	8,635.633
Organochlorine	Methoxychlor, other related	32.764
Organochlorine	Dicofol	5,135,043.572
Organochlorine	Toxaphene	5,126,412.090
Organochlorine	DDT	191.060
Organochlorine	Bandane	0.000

pan_classname	chem_name	Pounds
Organochlorine	Endosulfan	4,322,510.426
Organochlorine	Heptachlor, other related	164.492
Organochlorine	Lindane	48,354.580
Organochlorine	Heptachlor	427.219
Organochlorine	Endrin	199.703
Organomercury	PMA	855.985
Organophosphorus	Butonate	425.000
Organophosphorus	Crotoxyphos	80.800
Organophosphorus	DDVP	60,259.748
Organophosphorus	Dialifor	13,519.886
Organophosphorus	Chlorpyrifos	4,793,974.543
Organophosphorus	Dimethoate	6,453,429.323
Organophosphorus	Dicrotophos	281,339.101
Organophosphorus	Demeton	266,378.618
Organophosphorus	Carbophenothion	220,356.105
Organophosphorus	DDVP, other related	5,127.774
Organophosphorus	Bensulide	312,489.035
Organophosphorus	Diazinon	3,383,969.669
Organophosphorus	Dialifor, other related	1,498.794
Organophosphorus	Merphos, other related	85,186.709
Organophosphorus	Sulfotep, other related	0.943
Organophosphorus	Methyl parathion, other related	18,529.724
Organophosphorus	Methyl parathion	3,236,449.508
Organophosphorus	Sulprofos	632,104.011
Organophosphorus	Temephos	784.014
Organophosphorus	TEPP	20,843.378
Organophosphorus	Leptophos	13,272.196
Organophosphorus	TEPP, other related	31,267.591
Organophosphorus	Sulfotep	4,188.518
Organophosphorus	Fonofos	256,569.351
Organophosphorus	Merphos	2,585,826.011
Organophosphorus	Tetrachlorvinphos	11,794.293
Organophosphorus	Malathion	3,490,181.222
Organophosphorus	Trichlorfon	926,849.541
Organophosphorus	Leptophos, other related	1,510.378
Organophosphorus	Methamidophos	2,952,469.000
Organophosphorus	Acephate	2,711,769.163
Organophosphorus	Profenofos	1,245,077.628
Organophosphorus	Phosphamidon, other related	20,103.801
Organophosphorus	Phosphamidon	577,965.429
Organophosphorus	Phosmet	1,619,461.691
Organophosphorus	Phosalone	621,651.232
Organophosphorus	Phorate	2,552,006.895
Organophosphorus	Mevinphos	2,898,613.865
Organophosphorus	Parathion	8,411,249.416
Organophosphorus	Mevinphos, other related	1,923,122.681
Organophosphorus	Oxydemeton-methyl	1,361,364.774
Organophosphorus	Ronnel	0.754
Organophosphorus	S,S,S-tributyl phosphorotrithioate	8,353,953.203
Organophosphorus	Dioxathion	52,810.428
Organophosphorus	Naled	2,805,427.255
Organophosphorus	Monocrotophos	1,642,632.947
Organophosphorus	Methidathion	3,139,740.492

pan_classname	chem_name	Pounds
Organophosphorus	Parathion, other related	67,666.530
Organophosphorus	Ethoprop	98,969.622
Organophosphorus	Dioxathion, other related	22,173.566
Organophosphorus	Azinphos-methyl	4,988,416.405
Organophosphorus	Disulfoton	2,966,992.759
Organophosphorus	EPN	145,637.839
Organophosphorus	Ethephon	2,067,601.507
Organophosphorus	Ethion	876,055.134
Organophosphorus	Fenamiphos	435,226.006
Organophosphorus	Fensulfothion	202,682.656
Organophosphorus	Fenthion	117,233.875
Organotin	Fentin hydroxide	5,156.673
Organotin	Tributyltin resinate	3,050.880
Organotin	Fenbutatin-oxide	311,369.520
Organotin	Tributyltin neodecanoate	5.206
Organotin	Cyhexatin	542,355.856
Other Carbamate	Barban	172,724.463
Other Carbamate	Fenoxycarb	0.450
Other Carbamate	Asulam, sodium salt	3,249.737
Other Carbamate	Karbutilate	203.381
Other Carbamate	Propamocarb	1.057
Other Carbamate	Chlorpropham	255,139.144
Other Carbamate	Propham	1,122,106.051
Petroleum derivative	Petroleum hydrocarbons	49,361,250.028
Petroleum derivative	Petroleum distillates	1,330,329.121
Petroleum derivative	Naphtha, heavy aromatic	9,963.876
Petroleum derivative	Pentane	0.000
Petroleum derivative	Xylene	10,366,434.991
Petroleum derivative	Paraffin wax	5.754
Petroleum derivative	Petroleum derivative resin	26,306.370
Petroleum derivative	Xylene range aromatic solvent	6,242,941.441
Petroleum derivative	Ethylene	115.969
Petroleum derivative	Creosote	16,467.491
Petroleum derivative	Petroleum distillates, refined	1,857.915
Petroleum derivative	Petroleum naphthenic oils	66.096
Petroleum derivative	Cyclohexane	0.011
Petroleum derivative	MCIAL code 401	441,904.551
Petroleum derivative	Petroleum oil, unclassified	07,335,277.910
Petroleum derivative	Coal tar neutral oils and coal tar acid combinations	691.842
Petroleum derivative	Isoparaffinic hydrocarbons	55.305
Petroleum derivative	Kerosene	138,608.402
Petroleum derivative	Polybutenes	836.699
Petroleum derivative	Petroleum distillates, aromatic	15,308,369.558
Phenols	2,4-xylenol	3.802
Phenols	Para-tert-amylphenol, potassium salt	107.844
Phenols	Para-tert-amylphenol	16.162
Phenols	Ortho-phenylphenol, potassium salt	157.503
Phenols	Ortho-phenylphenol	103.123
Phenols	Sodium para-tert-amylphenate	79.032
Phenols	Meta-cresol	3.827
Phenols	Carbolic acid	1,803.374
Phenols	Thymol	0.001
Phenols	Ortho-phenylphenol, sodium salt	24,799.393

pan_classname	chem_name	Pounds
Pheromone	3,7,11-trimethyl-2,6,10-dodecatriene-1-ol	167.417
Pheromone	E-3,3-dimethyl-delta,alpha-cyclohexane ethanal	0.008
Pheromone	(E)-4-tridecen-1-yl-acetate	0.009
Pheromone	(Z,Z)-7,11-hexadecadien-1-yl acetate	1,143.228
Pheromone	8-dodecene-1-ol, other related	4.391
Pheromone	(Z,E)-7,11-hexadecadien-1-yl acetate	1,193.521
Pheromone	(Z)-4-tridecen-1-yl-acetate	0.000
Pheromone	(Z)-11-hexadecenal	203.894
Pheromone	Z-2-isopropenyl-1-methyl cyclobutane ethanol	0.016
Pheromone	E-8-dodecenyl acetate	7,259.354
Pheromone	Z-3,3-dimethyl-delta,alpha-cyclohexane ethanal	0.008
Pheromone	Z-3,3-dimethyl-delta,beta-cyclohexane ethanol	0.021
Pheromone	Muscalure	1.395
Pheromone	Myrcene	0.081
Pheromone	Z-8-dodecenol	1,095.753
Pheromone	Nerolidol	135.726
Pheromone	Z-8-dodecenyl acetate	126,011.323
Phosphonoglycine	Glyphosate, isopropylamine salt	2,780,499.157
Polyalkyloxy Compound	Nonyl phenoxy hydroxypoly (oxyethylene)	97,044.802
Polyalkyloxy Compound	Polyoxyethylene sorbitol, mixed ethyl ester	7,445.706
Polyalkyloxy Compound	Trimethyl ether of polyethylene glycol	7.908
Polyalkyloxy Compound	Polyoxyethylene polypropoxy propanol	551.404
Polyalkyloxy Compound	Alkylaryl polyglycol ether	298.769
Polyalkyloxy Compound	Nonylphenol alkylphenol ethoxylate 6 mole	17,175.492
Polyalkyloxy Compound	Alkyl polyoxy ethylene ether, monophosphoric acid ester	530.249
Polyalkyloxy Compound	Alkyl polyoxy ethylene ethers, polymerized resins and fatty	24,455.390
Polyalkyloxy Compound	Alkyl polyoxy ethylene glycols	33,806.573
Polyalkyloxy Compound	Alkylaryl poly(oxyethylene) glycol	749,913.465
Polyalkyloxy Compound	Isooctyl phenoxy polyethoxy ethanol	10,491.097
Polyalkyloxy Compound	Alkyl polyoxy alkylene ether	54,415.343
Polyalkyloxy Compound	Alkylaryl polyethylene glycol ether	2,163.983
Polyalkyloxy Compound	Alkyl polyethylene glycol ether	213.196
Polyalkyloxy Compound	Alkylaryl polyoxyethylene ether	102,141.796
Polyalkyloxy Compound	Alkylaryl polyoxyethylene glycol phosphate ester	171,772.288
Polyalkyloxy Compound	Alkylaryl poyloxyethylene ethanol	99,412.682
Polyalkyloxy Compound	Alpha-alkyl-omega-hydroxypoly (oxyethylene) ethanol	9,940.711
Polyalkyloxy Compound	Ethylene oxide adduct nonylphenol	1.882
Polyalkyloxy Compound	Ethoxylated linear alcohols	2,602.087
Polyalkyloxy Compound	Alkylaryl polyalkoxylated alcohols	68.631
Polyalkyloxy Compound	Alkyl phenyl poly (ethoxy) ethanol	12,406.681
Polyalkyloxy Compound	Polyoxyethylene mixed fatty acid ester	94,062.470
Polyalkyloxy Compound	Butoxy poly propylene glycol	0.351
Polyalkyloxy Compound	Poly (oxyethylene) ether	56.654
Polyalkyloxy Compound	Poly (methylene para nonylphenoxy) - poly (oxypropylene)	13,234.260
Polyalkyloxy Compound	Alkyl polyoxy ethylene ether, diphosphoric acid ester	265.204
Polyalkyloxy Compound	Octyl phenoxy poly ethoxy ethanol	212,157.657
Polyalkyloxy Compound	Polyoxyethylene polymer	9,034.536
Polyalkyloxy Compound	Nonyl phenoxy poly (ethylene oxy) ethanol	118,631.062
Polyalkyloxy Compound	Alkoxy poly (ethyleneoxy) ethyl phosphate	90.647
Polyalkyloxy Compound	Alkyl oxy poly (ethyleneoxy) ethyl phosphate	9.512
Polyalkyloxy Compound	Alkyl oxy polyethoxy ethanol	749.659
Polyalkyloxy Compound	Alkyl oxy-polyoxyethylene and alkyl phenyloxy-polyoxyethyl	33,460.399
Polyalkyloxy Compound	Alkyl phenoxy poly (ethoxy) ethanol	56,536.315

pan_classname	chem_name	Pounds
Polyalkyloxy Compound	a-(p-nonylphenyl)-omega-hydroxypoly (oxyethylene) with a	580.664
Polymer	Polyacrylic polymer	857.285
Polymer	Emulsifiable A-C polyethylene	504.420
Pyrethroid	Bifenthrin	10,229.045
Pyrethroid	Esfenvalerate	49,742.538
Pyrethroid	Permethrin	1,005,722.878
Pyrethroid	Phenothrin, other related	0.015
Pyrethroid	Fluvalinate (stereochemistry unspecified)	9,232.647
Pyrethroid	Flucythrinate	9,113.892
Pyrethroid	Fenvalerate	814,420.642
Pyrethroid	Resmethrin	725.589
Pyrethroid	Phenothrin	0.358
Pyrethroid	Resmethrin, other related	72.591
Pyrethroid	Tetramethrin	0.009
Pyrethroid	D-trans Allethrin	0.018
Pyrethroid	D-Allethrin	0.001
Pyrethroid	Cypermethrin, beta	99,269.206
Pyrethroid	Cyfluthrin	5,908.869
Pyridazinone	Norflurazon	177,150.166
Pyridazinone	Pyrazon	154,040.902
Pyridazinone	Pyrazon, other related	23,017.567
Pyridinecarboxylic acid	Picloram	3,537.983
Pyridinecarboxylic acid	Picloram, triisopropanolamine salt	499.088
Pyrimidine	Ancymidol	1.658
Pyrimidine	Fenarimol	27,336.125
Quaternary Ammonium Compoun	Alkyl (61%C12, 23%C14, 11%C16, 5%C8,C10,C18) dimet	0.500
Quaternary Ammonium Compoun	Chlormequat chloride	988.816
Quaternary Ammonium Compoun	Mepiquat chloride	52,487.780
Quaternary Ammonium Compoun	Alkyl (90%C14, 5%C12, 5%C16) dimethyl ethyl ammonium	0.574
Quaternary Ammonium Compoun	Alkyl (90%C14, 5%C12, 5%C16) dimethyl dichlorobenzyl a	2.613
Quaternary Ammonium Compoun	Dioctyl dimethyl ammonium chloride	22.119
Quaternary Ammonium Compoun	Alkyl (67%C12, 25%C14, 7%C16, 1%C8,C10,C18) dimethy	85.406
Quaternary Ammonium Compoun	Alkyl (60%C14, 30%C16, 5%C12, 5%C18) dimethylbenzyl	401.237
Quaternary Ammonium Compoun	Alkyl (58%C14, 28%C16, 14%C12) dimethylbenzyl ammon	4.461
Quaternary Ammonium Compoun	Alkyl (50%C14, 40%C12, 10%C16) dimethylbenzyl ammon	59.427
Quaternary Ammonium Compoun	N-Dialkyl (60%C14, 30%C16, 5%C12, 5%C18) methyl ben	0.005
Quaternary Ammonium Compoun	Octyl decyl dimethyl ammonium chloride	44.237
Quaternary Ammonium Compoun	Alkyl (68%C12, 32%C14) dimethylethylbenzyl ammonium c	400.798
Quaternary Ammonium Compoun	Didecyl dimethyl ammonium chloride	22.756
Quaternary Ammonium Compoun	Dimethyl dicoco ammonium chloride	87.347
Silicone	Dimethyl poly siloxane	910.374
Silicone	Dimethyl silicone fluid emulsion	292.554
Silicone	Compounded silicone	1,934.490
Silicone	Silicone defoamer	847.408
Soap	Potash soap	238,193.030
Soap	Diethylamine salt of coconut fatty acid	6,260.554
Soap	Ammonium oleate	169.234
Soap	Oleic acid, methyl ester	19,877.188
Soap	Ammonium tall oil fatty acid soap	1,144.620
Soap	Triethanolamine dodecylbenzene sulfonate	28.212
Soap	Oleic acid, potassium salt	331.257
Soap	Ethylene glycol, oleic ester	0.201
Soap	Oleic, linoleic and resin acids, sodium salts	2,053.004

panclassname	chem_name	Pounds
Soap	Sodium dodecylbenzene sulfonate	680.004
Soap	Coconut oil soap	715.676
Soap	Free fatty acids and/or amine salts	10,720.151
Soap	Dodecylbenzene sulfonic acid	25,849.961
Soap	Sodium xylene sulfonate	7,651.892
Soap	Petroleum sulfonates	0.615
Soap	Soap	279.561
Substituted Benzene	Chlorothalonil	3,646,838.109
Substituted Benzene	Dichlobenil	8,709.050
Substituted Benzene	Chloroneb	47,266.651
Substituted Benzene	PCNB	459,469.017
Substituted Benzene	Dichloran	1,543,057.489
Sulfonylurea	Thifensulfuron-methyl	3.234
Sulfonylurea	Bensulfuron methyl	41,574.036
Sulfonylurea	Sulfometuron methyl	31,261.665
Sulfonylurea	Chlorsulfuron	2,148.374
Thiocarbamate	Butylate	97,600.270
Thiocarbamate	Vernolate	24,160.407
Thiocarbamate	Triallate	3,140.161
Thiocarbamate	Thiobencarb	2,025,212.274
Thiocarbamate	Pebulate	763,870.785
Thiocarbamate	Molinate	13,192,432.042
Thiocarbamate	EPTC	1,345,846.863
Thiocarbamate	Cycloate	161,065.531
Thiocarbamate	Diallate	395.718
Thiophthalimide	Captan, other related	83,798.577
Thiophthalimide	Captan	4,967,151.492
Thiophthalimide	Folpet	416,229.909
Thiophthalimide	Captafol (cis isomer)	2,100,154.497
Triazine	Cyanazine	786,912.424
Triazine	Metribuzin	133,662.551
Triazine	Propazine	619.278
Triazine	Simazine	1,640,907.266
Triazine	Terbutryn, other related	94.742
Triazine	Anilazine	600,544.420
Triazine	Dichloro-s-triazinetrione	12,037.879
Triazine	Prometon	2,758.806
Triazine	Hexazinone	449,034.648
Triazine	Sodium dichloro-s-triazinetrione	0.190
Triazine	Prometryn	818,503.999
Triazine	Sodium dichloro-s-triazinetrione dihydrate	0.376
Triazine	Atrazine	514,366.600
Triazine	Atrazine, other related	22,086.623
Triazine	Terbutryn	1,800.090
Unclassified	Vinyl resin, synthetic	11.358
Unclassified	Phthalic glycerol alkyl	41,945.082
Unclassified	Sodium TCA	57,484.465
Unclassified	Methyl isothiocyanate	83,707.819
Unclassified	Phosphate esters, miscellaneous	37.172
Unclassified	Vinyl polymer	15,021.402
Unclassified	Piperalin	17,030.659
Unclassified	Poly-i-para-menthene	653,614.570
Unclassified	Piperonyl butoxide	112,691.491

pan_classname	chem_name	Pounds
Unclassified	Sec-butylamine	2,136.753
Unclassified	Propylene glycol, methyl ester	25,461.593
Unclassified	Propionic acid	2,368.275
Unclassified	Propargite	17,301,294.536
Unclassified	Polyamine polymer	2,928.735
Unclassified	Plastic polymers	4,443.407
Unclassified	Polyalkylene ether	283.252
Unclassified	Polyacrylamide polymer	17,727.399
Unclassified	Poly(oxyethylene) (dimethylimino) ethylene (dimethylimino)	1,228.827
Unclassified	Triforine	53,677.369
Unclassified	Diphenylamine	1,083.307
Unclassified	Ethofumesate	39,274.939
Unclassified	Oxythioquinox	113,568.151
Unclassified	Endothall, mono [N,N-dimethyl alkylamine] salt	109,835.301
Unclassified	Endothall, mono (N,N-diethyl alkylamine) salt	682,730.233
Unclassified	Endothall, disodium salt	7,412.548
Unclassified	Endothall, dipotassium salt	93,185.943
Unclassified	Endothall, di (N,N-dimethylalkylamine) salt	0.448
Unclassified	Ethyl acrylate	268.022
Unclassified	Dipropyl isocinchomeronate	0.020
Unclassified	Amitrole	40,200.280
Unclassified	Dikegulac sodium	18.950
Unclassified	Difenzoquat methyl sulfate	478,507.651
Unclassified	Bentazon, sodium salt	851,260.252
Unclassified	Dazomet	21,383.010
Unclassified	Dalapon, sodium salt	162,135.383
Unclassified	Cyclohexanone	0.139
Unclassified	Chloropicrin	19,008,302.257
Unclassified	Chlorobenzilate	344,931.544
Unclassified	Endothall, di (N,N-diethylalkylamine) salt	27,696.221
Unclassified	Malachite green	0.430
Unclassified	Modified phthalic glycerol alkyd resin	348,615.270
Unclassified	Acrylic acid	41.688
Unclassified	Formaldehyde	491.353
Unclassified	Malic acid	74.271
Unclassified	Maleic hydrazide, potassium salt	150,389.975
Unclassified	Methyl methacrylate	181.893
Unclassified	Maleic hydrazide, diethanolamine salt	281,251.857
Unclassified	Menthol	393.599
Unclassified	Lactic acid	127.829
Unclassified	Acid yellow 23	1.765
Unclassified	Korax	3,418.086
Unclassified	Inert ingredients	0.935
Unclassified	Hydrogen cyanamide	291,668.716
Unclassified	Fosetyl-Al	529,679.746
Unclassified	Acid blue 9, diammonium salt	17.448
Uracil	Bromacil	291,183.098
Uracil	Bromacil, lithium salt	61.232
Uracil	Terbacil	15,316.974
Urea	Siduron	3,461.000
Urea	Monuron	384.400
Urea	Thidiazuron	16,933.763
Urea	Norea	10,958.486

pan_classname	chem_name	Pounds
Urea	Norea, other related	576.458
Urea	Diuron	2,152,844.244
Urea	Linuron	296,243.241
Urea	Chloroxuron	153,483.004
Urea	Fluometuron	64,966.053
Urea	Tebuthiuron	1,932.445
Xylylalanine	Metalaxyl	306,540.120